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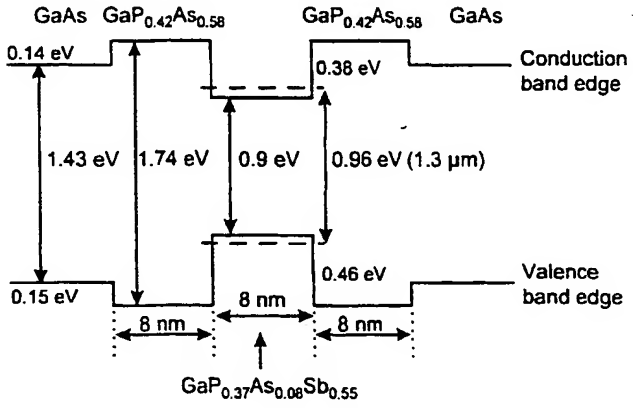
(54) Title: LONG WAVELENGTH PSEUDOMORPHIC InGaNPAsSb TYPE-I AND TYPE-II ACTIVE LAYERS FOR THE GAAS MATERIAL SYSTEM



(57) Abstract: The invention discloses improved structures of light-processing (e.g., light-emitting and light-absorbing/sensing) devices, in particular Vertical Cavity Surface Emitting Lasers (VCSELs), such as may find use in telecommunications applications. The disclosed VSCAL devices and production methods provide for an active region having a quantum well structure grown on GaAs-containing substrates, thus providing processing compatibility for light having wavelength in the range 1.0 to 1.6 μm. The active region structure combines strain-compensating barriers with different band alignments in the quantum wells to achieve a long emission wavelength while at the same time decreasing the strain in the structure. The improved functioning of the devices disclosed results from building them with multicomponent alloy layers having a large number of constituents. The invention discloses as a key constituent in the proposed alloy layers for the active region a substance, such as nitrogen (N), suitable for reducing bandgap energy (i.e., increasing light wavelength) associated with the layers, while at the same time lowering the lattice constant associated with the structure and hence lowering strain.

WO 01/33677 A3

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01S5/343 H01L31/00 H01L33/00 H01L31/18 H01S3/19

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 960 018 A (JEWELL JACK L ET AL) 28 September 1999 (1999-09-28) column 26, line 54 -column 28, line 50; figures 8-11 column 38, line 8 -column 39, line 10 ---	1-6, 14-26
X	HAINS C P ET AL: "ROOM-TEMPERATURE PULSED OPERATION OF TRIPLE-QUANTUM-WELL GAINNAS LASERS GROWN ON MISORIENTED GAAS SUBSTRATES BY MOCVD" IEEE PHOTONICS TECHNOLOGY LETTERS,IEEE INC. NEW YORK,US, vol. 11, no. 10, October 1999 (1999-10), pages 1208-1210, XP000880896 ISSN: 1041-1135 the whole document --- -/--	1-6, 14-23

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hervé, D

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GOKHALE M R ET AL: "HIGH-PERFORMANCE LONG-WAVELENGTH (LAMBDA 1.3 MUM) INGAASPN QUANTUM-WELL LASERS" IEEE PHOTONICS TECHNOLOGY LETTERS,IEEE INC. NEW YORK,US, vol. 11, no. 8, August 1999 (1999-08), pages 952-954, XP000860961 ISSN: 1041-1135 the whole document	1-6, 14-23
X	MIYAMOTO T ET AL: "A NOVEL GALNNAS-GAAS QUANTUM-WELL STRUCTURE FOR LONG-WAVELENGTH SEMICONDUCTOR LASERS" IEEE PHOTONICS TECHNOLOGY LETTERS,US,IEEE INC. NEW YORK, vol. 9, no. 11, 1 November 1997 (1997-11-01), pages 1448-1450, XP000722969 ISSN: 1041-1135 the whole document	1-7
X	EP 0 833 395 A (CANON KK) 1 April 1998 (1998-04-01) column 10, line 25 -column 11, line 42; figure 3	1-11
A	EP 0 896 406 A (MATSUSHITA ELECTRIC IND CO LTD) 10 February 1999 (1999-02-10) figure 9A	1
A	JOHNSON S R ET AL: "Long wavelength pseudomorphic InGaPAsSb type-I and type-II active layers grown on GaAs" 18TH NORTH AMERICAN CONFERENCE ON MOLECULAR BEAM EPITAXY, BANFF, ALTA., CANADA, 10-13 OCT. 1999, vol. 18, no. 3, pages 1545-1548, XP002172052 Journal of Vacuum Science & Technology B (Microelectronics and Nanometer Structures), May 2000, AIP for American Vacuum Soc, USA ISSN: 0734-211X the whole document	1-44

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5960018 A	28-09-1999	US 5825796 A	20-10-1998
		AU 4588597 A	17-04-1998
		WO 9813879 A	02-04-1998
EP 0833395 A	01-04-1998	JP 10152399 A	09-06-1998
		US 6046096 A	04-04-2000
EP 0896406 A	10-02-1999	JP 11288886 A	19-10-1999
		JP 11112096 A	23-04-1999